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SUBJECT: Initiation Sequence for High-
Priority Medical Experiments
During the AAP-1/AAP-2 Mission -
Case 610

DATE: December 19, 1968

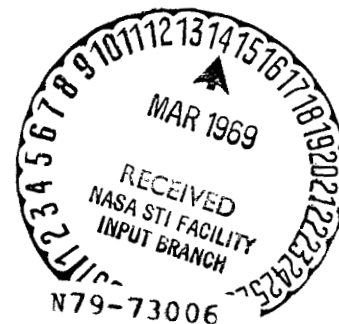
FROM: D. J. Belz

ABSTRACT

The MDA has been designed to support the operation of certain medical experiments as early as the second day of AAP-1/AAP-2. Crew time requirements and constraints, however, prohibit the initiation of all such experiments on that day. All MDA medical experiments can be performed at least once by one crewman by the end of the third mission day; all can be performed at least once by each crewman by the end of the fifth day.

The medically preferred order in which the experiments should begin has not yet been established. If any medical experiments require initiation prior to the third mission day and if required starting times are not mutually compatible with available crew time, a priority ranking will be needed to define the initiation sequence. Such a priority order, if established, should consider: (1) the relative medical importance of early observations for each experiment as opposed to other experiments and (2) the relative importance of performing a given experiment on more than one man early in the mission, as opposed to initiating another experiment.

(NASA-CR-100235) INITIATION SEQUENCE FOR
HIGH-PRIORITY MEDICAL EXPERIMENTS DURING THE
AAP-1/AAP-2 MISSION (Bellcomm, Inc.) 8 p



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MEMORANDUM FOR FILE

1.0 Background

Most medical experiments assigned to the AAP-1/AAP-2 mission were originally planned for performance in the Orbital Workshop (OWS). Crew timelines issued by MSC in April 1968, however, indicated that activation of the OWS would not be completed until the seventh day of the twenty-eight day mission (Reference 1). This implied that critical medical data could not be obtained from the crew before the eighth day of the flight.

Since significant physiological changes occur after even a few hours of space flight, inability to obtain data during the early days of the mission would have eliminated the possibility of observing much of the onset of such changes. Therefore the Multiple Docking Adapter (MDA) baseline configuration was altered to support the operation of high-priority medical experiments prior to activation of the OWS (Reference 2).^{*} The MDA will be operational approximately one day after the liftoff of AAP-1; experiments within the MDA can therefore be initiated as early as the second day of the flight.

Subsequent to the MDA baseline change, the writer undertook a study to determine whether adequate crew time was available for all experiments then assigned to AAP-1/AAP-2 (Reference 3). Timelines for each crewman throughout the mission were constructed from crew-time requirements of experiments, meals, and sleep periods, as well as mission-imposed constraints on the crew's activities. High-priority medical experiments to be performed in the MDA were generally initiated as early as possible in the mission. Nevertheless, it was not possible to initiate all such experiments within the second day of the mission.

The timelines generated in Reference 3 are, of course, not the only possible timelines that will satisfy experiment requirements. They are, however, representative of the amount

^{*}The high-priority experiments are M018, M050, M051, M055, and M058, which are referred to within MSC as M093, M171, M092, M151, and M172, respectively. The fecal drier and experiment support system are also initially used in the MDA.

of mission time required to initiate the MDA medical experiments. This memorandum reviews the initiation sequence of those experiments, as constructed in Reference 3, to determine the need for:

- a) defining priorities on the sequence in which experiments are to be initiated, and
- b) developing initiation strategies in support of further timelining efforts.

2.0 Analysis of Representative Initiation Sequence

Table 1 summarizes the order in which the MDA medical experiments are begun as shown in the crew timelines of Reference 3. Experiment M058 is performed during the breakfast period of each crewman after completion of MDA activation. Crew-time requirements of M055 are defined as being incorporated in the requirements of other experiments and are therefore not scheduled separately. Experiment M050 is performed in three parts designated Mode A - Resting Metabolic Rate and Bicycle Ergometry, Mode B - Unsuiting Maintenance and Constant Work Task, and Mode C - Suited Maintenance and Constant Work Task.

Table 1 indicates that the first performance of each experiment by any crewman occurs as follows:

Experiment Number	Initiation Time (hours:Minutes from AAP-1 Liftoff)
M050 - Mode A	29:00
M018	32:35
M058	34:15
M050 - Mode B	47:55
M050 - Mode C	70:30
M051	224:27

Thus Experiment M050 (Modes A and B only), M018, and M058 are performed at least once during the second day of the mission. Mode C of M050 is first performed near the end of the third mission day. M051, first performed on the tenth mission day, could have been scheduled as early as the third day by delaying the initial inspection of the S-IVB LH₂ tank interior and completion of OWS activation.

TABLE I
FIRST PERFORMANCE OF EACH MDA MEDICAL EXPERIMENT BY
EACH CREWMAN, BASED ON REFERENCE 3

MISSION DAY	GET (HOURS:MINUTES)	CREWMAN		
		1	2	3
2	29:00			M050 (MODE A)
2	30:30		M050 (MODE A)	
2	32:35			M018
2	33:25		M018	
2	34:15	M058		
2	43:30		M058	M058
2	44:30	M050 (MODE A)		
2	46:00	M018		
2	47:55			M050 (MODE B)
3	49:20		M050 (MODE B)	
3	68:15	M050 (MODE B)		
3	70:30	M050 (MODE C)		
4	77:35		M050 (MODE C)	
4	79:35			M050 (MODE C)
10	224:27			M051
10	237:22	M051		

EXPERIMENT NUMBER	EXPERIMENT NAME
M018	IN-FLIGHT VECTORCARDIOGRAM
M050	METABOLIC COSTS OF IN-FLIGHT TASKS
M051	CARDIOVASCULAR FUNCTION
M055	TIME AND MOTION STUDY
M058	BODY MASS MEASUREMENT DEVICE

- NOTES:
- 1) GET = GROUND ELAPSED TIME MEASURED FROM LIFTOFF OF AAP-1
 - 2) CREW TIME REQUIRED BY M055 IS INCLUDED IN OTHER EXPERIMENTS
 - 3) M051 COULD HAVE BEEN SCHEDULED AS EARLY AS DAY 3 FOR CREWMAN 3 AND DAY 5 FOR CREWMAN 1 BY DELAYING THE INITIAL INSPECTION OF THE S-IVB AND COMPLETION OF OWS ACTIVATION
 - 4) M051 IS NOT PERFORMED ON CREWMAN 2, THE PHYSICIAN-ASTRONAUT

The first time each MDA medical experiment has been performed at least once by each crewman is indicated by the following:

Experiment Number	Initiation Time for "Final" Crewman (Hours:Minutes from AAP-1 Liftoff)
M058	43:30
M050 - Mode A	44:30
M018	46:00
M050 - Mode B	68:15
M050 - Mode C	79:35
M051	237:22

Thus Experiments M058, M050 (Mode A only), and M018 are performed at least once by each crewman during the second mission day. Mode B of M050 has been performed by each man by the end of the third day; Mode C of M050 has not been performed by each man until the fourth mission day. M051 could have been performed by both non-physician astronauts as early as the fifth day by delaying OWS activation as mentioned previously.

All of the high-priority medical experiments can be performed in the MDA at least once by the end of the third mission day measured from AAP-1 liftoff; all such experiments can be performed at least once by each crewman by the end of the fifth day.*

3.0 Priorities on Initiation Sequence of MDA Medical Experiments

The previous section of this memorandum showed that some MDA medical experiments can be initiated as early as the second mission day, but that all such experiments will not have begun until the third to fifth day. If any experiments will be significantly enhanced by starting times earlier than the third day, it will be desirable to establish those times as formal requirements. Subsequently, if the desired initiation times are not mutually compatible with available crew time, a priority ranking will be needed to determine the sequence in which experiments are to begin.

To date no such priorities have been defined. If and when they are, the following considerations should be included:

1. Relative medical importance of early observations for each experiment as opposed to other experiments.

*M051, which is to be performed on only two of the three crewmen, is of course excepted.

2. Relative importance of performing a given experiment on more than one man early in the mission as opposed to initiating another experiment. For example, if two experiments, A and B, are to be performed on each crewman as early as possible in the mission, priorities are needed to determine the sequence of initiation. The priorities must be capable of distinguishing which of the following or other initiation sequences is most desirable:

a. <u>Initiation Time*</u>	<u>Crewman</u>		
	1	2	3
t_1	A		
t_2		A	
t_3			A
t_4	B		
t_5		B	
t_6			B

b. <u>Initiation Time*</u>	<u>Crewman</u>		
	1	2	3
t_1	A		
t_2		B	
t_3			A
t_4	B		
t_5		A	
t_6			B

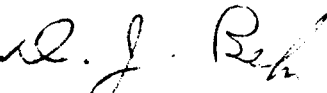
4.0 Summary

The medically preferred order in which experiments should be initiated in the MDA has not yet been established. If any medical experiments require initiation prior to the third mission day and if required starting times are not mutually compatible with available crew time, a priority ranking will be needed to define the initiation sequence. Such a priority order,

* $t_{i+1} > t_i$, $i = 1, \dots, 5$

if established, should consider: (1) the relative medical importance of early observations for each experiment as opposed to other experiments and (2) the relative importance of performing a given experiment on more than one man early in the mission, as opposed to initiating another experiment.

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BELLCOMM, INC.

References

1. Reference Flight Plan, Apollo Applications Mission AAP-1/AAP-2 - Revision A, MSC/FCSD, April 15, 1968.
2. Letter from ML/Director, Apollo Applications Re: Status of MDA Task Force Activities, June 24, 1968.
3. D. J. Belz, Experiment Scheduling for the AAP-1/AAP-2 Mission - Case 610, Bellcomm Memorandum for File, December 11, 1968.